IMPACT OF CONSTRUCTIVISM VIA THE BIOLOGICAL SCIENCES CURRICULUM STUDY (BSCS) 5E MODEL ON STUDENT SCIENCE ACHIEVEMENT AND ATTITUDE

by

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Karla B. Cramer

July 2012
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ABSTRACT

The investigation involved implementing constructivist instruction via the Biological Sciences Curriculum Study 5E Instructional Model to determine its’ impact on student achievement and attitude. The study included 68 seventh grade Life Science students of average to above average achievement at a community based K-12 school in Florence, Montana. Treatment was implemented during a six week biome unit in which student achievement was assessed through the Evaluation Association Measured Academic Progress and summative assessments. Student attitude was evaluated through the Test of Science Related Attitudes and learning preference surveys, pre- and post-treatment. The effectiveness of constructivism approach to instruction on achievement via the BSCS 5E Instructional Model in the science classroom was not conclusively supported by data.
INTRODUCTION AND BACKGROUND

Florence Carlton Middle School in Florence, Montana has 911 students in kindergarten through 12th grade. Since the campus includes all thirteen grades, the culture is different than an all middle school campus because students of all grades have opportunities to interact throughout the school day. These interactions and low student numbers help foster a community connection throughout the school. In addition, Florence Carlton School District is primarily white with less than a 5% minority population. The Florence community has an unemployment rate of 10.4% with 20.2% of the residents living in poverty. Despite this hardship, many parents actively support the school (city-data.com).

The treatment population was a group of 68 seventh grade life science students broken into three periods. The students were in my sixth grade earth science class the previous year so they were familiar with my general class expectations and procedures. In general, the students were of average to above average academic ability with five special needs students that had individual education plans.

To meet the needs of my students and the Montana mandate to provide inquiry based science instruction, the purpose of this study was to measure the impact of implementing constructivist instruction via the Biological Sciences Curriculum Study 5E Instructional Model (BSCS 5E’s) on student achievement, attitude and learning preference. I was also curious about the impact of constructivist instruction on my personal attitude regarding my success in providing valuable and interesting lessons.
CONCEPTUAL FRAMEWORK

Constructivism in science education is based upon a philosophy that all learning is constructed and that new knowledge is built upon the prior experiences of the learner (Fox, 2001; Gil-Pérez et al., 2002; Hoover, 1996; Kruckeberg, 2006; Naylor, 1999; Toh, Ho, Chew, & Riley II, 2003). The foundation of constructivism is attributed to the work of Dewey, Piaget, and Vygotsky who maintain that how students respond to new learning situations is influenced by their prior knowledge (Hyslop-Margison & Strobel, 2011). This philosophy has influenced a change in science curriculum and instruction to take into account students’ experiences (Osborne, 1996). Fox (2001) asserts that the foundation of constructivism is based upon the idea that learning is not passively absorbed. It is an active process in which knowledge is both invented and personal to the learner. The key for learning is fundamentally linked to the active participation of the learner. New knowledge can only be constructed by linking meaning to the learner’s previous, existing knowledge (Naylor, 1999).

Construction of science knowledge is dependent upon the experiences the student brings into the classroom (Kruckeberg, 2006). With that in mind, teaching is more than filling the learner’s head with prepackaged pieces of information that the learner dumps after tests (Roth, 1990). These “downloaded” pieces of knowledge have little value to the learner unless he is able to organize and process the information in relationship to his current understandings and previous experiences (Henze, 2008; Hoover, 1996; Kruckeberg, 2006).

The constructive process of learning is considered an inquiry process that is student-centered. The learner constantly is referencing new knowledge to prior
experiences to either build upon what he already knows or to modify existing knowledge. Actively processing information involves examining new information, organizing the information and comparing interpretations with others, all the while trusting that the new knowledge is worth the effort of integration. For students to be able to compare their interpretations to their peers, they must first be able to express their understanding of the information. This articulation process alone helps the student to organize and evaluate his understanding. Discussion with peers exposes students to perspectives that may be different from their own and may ultimately result in a different or deeper understanding of concepts (Henze, 2008; Hoover, 1996). The process of integrating knowledge takes time since pre-existing knowledge and beliefs are resistant to change. Because of this, it is important that students be given time necessary for integration of the new material (Hoover, 1996; Hyslop-Margison & Strobel, 2011).

Instruction following the constructivist method does not mean abandoning all traditional instructional tools, such as lecture, which is a viable tool when appropriately used (Hyslop-Margison & Strobel, 2011). Constructivist instruction relies heavily on problem-solving and inquiry-based activities that encourage students to form and test their own ideas, ultimately drawing their own conclusions which they share in a cooperative learning environment. Throughout this process, the teacher is constantly evaluating student understanding and providing a nudge, when necessary, to consider new ideas or materials to solve problems. Students are able to refine their thinking by being given as many opportunities as possible to practice and apply their newly-gained knowledge (Toh et al., 2004).
When an instructor delivers new content using a constructivist model, such as Biological Sciences Curriculum Study 5E Instructional Model (BSCS 5E’s), students find meaning in new material because it connects with their pre-existing beliefs and personal knowledge. The BSCS 5E’s is an inquiry-based instructional model based upon the constructivist philosophy of learning that provides strong guidance and support for instruction (Wilson, Taylor, Kowalski & Carlson, 2010). BSCS 5E’s was developed by Rodger Bybee in the 1980’s, based upon the philosophy and psychology of Johann Herbart. Herbart believed the best way for students to learn was to allow them to discover relationships amongst their experiences, to incorporate direct instruction which explained concepts, and to provide opportunities for demonstration of understanding. The BSCS 5E’s model consists of five phases that guide instruction to assist students in developing a better understanding of science and technology (Bybee, 2009). The five phases of the 5 E model are engagement, exploration, explanation, elaboration, and evaluation (Table 1).
Table 1
5E Learning Cycle, teacher and student roles (Adapted from Bybee, 1997 & 2009)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Goal</th>
<th>Teacher’s Role</th>
<th>Student’s Role</th>
</tr>
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</table>
| **Engagement** | • Stimulate student curiosity  
• Connect to prior experiences  
• Access prior knowledge  
• Expose prior thinking | • Generate interest through demonstrations, discrepant events, etc.  
• Assess current understanding through discussion, formative assessment, etc.  
• Elicit prior thinking  
• Create curiosity | • Ask questions  
• Access prior knowledge and experiences  
• Organize thinking |
| **Exploration** | • Provide common experiences for students  
• Facilitate conceptual change | • Provide opportunities for students to work cooperatively  
• Observe student interactions  
• Probe student conceptions  
• Redirect student understanding when necessary | • Work with peers  
• Problem solve  
• Test predictions and hypotheses  
• Record observations, data, and ideas |
| **Explanation** | • Focus students’ attention on concept  
• Provide opportunities for demonstration of knowledge, processes and/or behaviors.  
• Provide conceptual information  
• Develop deeper comprehension | • Ask for evidence  
• Encourage students to clarify understanding  
• Explain concepts based upon student experiences  
• Provide explanations of scientific concepts and vocabulary | • Explain solutions to problems to peers  
• Critically listen to peers’ and teacher’s explanations  
• Substantiate explanations with observations and data |
| **Elaboration** | • Challenge students’ understanding of concepts  
• Extend students’ understanding and skills  
• Provide practice for students to apply conceptual understanding | • Expect students to apply understanding, processing skills, and new vocabulary to similar situations  
• Elicit and refer students to alternative explanations | • Apply new vocabulary, definitions, and skills to similar situations  
• Design experiments based upon new knowledge  
• Record data and observations  
• Develop new explanations |
| **Evaluation** | • Assess understanding and student progress | • Observe and evaluate student application of new concepts  
• Encourage self-assessment by students  
• Ask thought-provoking questions | • Demonstrate understanding of concepts  
• Use observations and evidence to answer questions  
• Evaluate progress and knowledge |
Cognitive research has shown that the active process occurring within constructivism can profoundly contribute to student learning in the science classroom (Bybee, 2009; Hyslop-Margison & Strobel, 2011). Wilson’s et al. (2010), research found that students who were instructed using an inquiry-based constructivist strategy gained significantly greater achievement over students who were instructed with traditional teaching strategies. Greater student achievement was consistent regardless of race or gender across an array of learning objectives. Geier et al. and Blanchard, Annetta, and Southerland (as cited by Wilson et al., 2010) found significant achievement levels in students who received inquiry-based instruction. As a constructivism-based model, the BSCS 5E Instructional Model has been shown to effectively contribute to student success in mastering science concepts (Bybee, 2009).

If new content is not connected to students’ prior experiences, it is difficult for the student to find it meaningful, which impacts their ability to assimilate the new information (Kruckeberg, 2006). Another benefit of BSCS 5E learning is the cooperative learning environment in which students interact with their peers to solve problems. An environment that encourages students to share ideas magnifies the learning of the individual, allowing students to have greater achievement than they would have as an individual (Roth, 1990).

A persistent challenge to science education is student alienation. Students view science as too difficult and not relevant to their lives (Kruckeberg, 2006). Thus, it is critical that instruction in science classrooms engage learners by piquing their curiosity and providing opportunities for success. Constructivist-based classrooms encourage students to take risks, resulting in higher achievement and stronger student interest (Roth,
1990). This instructional method ultimately satisfies both the instructor’s hope for and the students’ need for a meaningful science education, especially as it relates to the everyday world.

METHODOLOGY

Treatment

The purpose of the study was to determine the impact of implementing the constructivist paradigm using the Biological Sciences Curriculum Study 5E (BSCS 5E’s) Instructional Model on student achievement in the middle school science classroom. In addition to the focus on students’ achievement, the study investigated the impact of constructivist-structured lessons on students’ attitudes about science and whether inquiry affected student learning style preference. All instruction during the eight week treatment period was based upon the constructivist paradigm using the BSCS 5E’s.

Treatment was implemented during a six week biome unit in which each phase of the unit was designed in accordance with the 5E Instructional Model. During the engagement phase, students drew a simple biome model based upon their prior knowledge and acted as “Biome Detectives” to identify biomes based upon precipitation and temperature data. A variety of activities from student-designed soil investigations to research on specific biomes was included in the exploration phase. Students worked in teams of two to three students to demonstrate their knowledge by creating and presenting a biome model based upon their own research, as well as, their note-taking efforts during their classmates’ presentations during the explanation phase. To provide an opportunity for students to apply their newly-gained knowledge, they designed a biome in an
unknown location based upon precipitation and temperature data in the elaboration phase. In order to assess students’ understanding in the evaluation phase, students completed a written assessment about the abiotic and biotic components and interactions in a variety of biomes. Complete lists of unit activities are found in Appendix A.

**Data Collection**

Prior to implementation of the treatment plan, students completed the Learning Preference Questionnaire (Appendix A) and the Measured Academic Progress (MAPs) assessment on science to establish a learning preference and pre-treatment science knowledge score. Learning Preference Questionnaire responses were grouped by response, then each group of responses were categorized by similar student explanations. MAP Science assesses student’s ability to understand and use scientific concepts and processes as well as general science knowledge in multiple areas: life science, earth and space science, and physical science (NWEA, n.d.). Student progress in science was assessed in the spring following the treatment plan. Fall, pre-treatment Rasch unit (RIT) scores were compared to the spring post-treatment scores to determine change in science knowledge. RIT scores are an equal-interval unit that measures a test items difficulty, ultimately estimating student achievement. The score allows the teacher to determine the student’s academic growth based upon the curriculum and their prior achievement (NWEA, n.d.). Additionally, the treatment students’ pre- and post-treatment MAP scores were compared to the prior year’s, 2010 – 2011, student scores who received traditional instruction and NWEA’s fall and spring expected achievement for grade seven. The non-treatment group consisted of 64 students of average to above average achievement with 4
special needs students. Both study groups had similar classroom experiences excluding the treatment plan.

Upon completion of the treatment plan, the students were evaluated with a teacher-developed summative assessment on concepts presented during the unit. Summative assessment scores of the students involved in the treatment plan were compared to the summative assessment scores of the previous year’s, 2010 – 2011, students who received traditional instruction during the unit. The mean of student scores for the summative assessment following traditional instruction was compared to the mean of the student scores following the treatment to determine the change. This information was used to determine the impact of constructivist instruction on student knowledge.

The Test of Science Related Attitudes (TOSRA) was used to determine the impact of constructivist instruction on student attitudes towards science. TOSRA, developed by Barry J. Fraser (1981), measures a relative change in student attitudes in seven science-related categories or scales: Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. Survey items are written in a positive or negative form. Students completed the TOSRA pre-test before the treatment period and a post-test following the treatment period. Responses were grouped based upon scale and the responses to positive items Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree were scored as 5, 4, 3, 2, and 1 respectively. Negative survey items Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree were scored as 1, 2, 3, 4, 5. Any omitted responses were scored as a 3. The averages of the pre-
treatment and averages of the post-treatment scores were compared to determine the impact of constructivist-based instruction on student attitudes towards science.

Following instruction based upon the 5E Instructional Model, students completed the Inquiry Based Instruction Questionnaire which assessed their comfort in learning from constructivist based instruction. Students responded to a series of statements about inquiry based projects by either selecting Agree or Disagree and then elaborated further by providing comments (Appendix B). The mean percentage of students who selected Agree on the questions pertaining to learning style was compared to those who selected Disagree to determine the impact of the treatment on student comfort. Student comments provided insight into their selections.

The Data Triangulation Matrix outlines the data collection methods that were used to determine the impact of constructivist instruction on student achievement and science-related attitudes (Table 2).
### Table 2
Data Triangulation Matrix

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Focus Question:</strong> How does implementing constructivism via the BSCS 5E Instructional Model impact student achievement?</td>
<td><strong>Data Source</strong></td>
</tr>
<tr>
<td></td>
<td>1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. Focus Sub-question 1: Does constructivist structured lessons impact students’ attitude about science?</td>
<td>Test of Science Related Attitudes (TOSRA) of student’s attitudes about science, pre-treatment.</td>
</tr>
</tbody>
</table>
DATA AND ANALYSIS

To determine the effectiveness of implementing constructivism on achievement via the BSCS 5E Instructional Model in the science classroom, the seventh grade students were evaluated with the Biome Test, a summative assessment of concepts presented during the treatment period (Appendix H). The mean of student assessment scores upon completion of the treatment plan was 89% ($N=62$). Compared to the prior year’s students who received traditional instruction during the same unit, the treatment students scored 4% higher than the non-treatment students, whose mean score was 85% ($N=64$) (Figure 1).

Eighty-two percent of the treatment students scored a B or higher, compared to only 72% of the non-treatment students. None of the treatment students failed the Biome Test, while three of the non-treatment students failed (Figure 2 & Figure 3).

Figure 1. Unit Summative Assessment, 2011 Students ($N=64$), 2012 Students ($N=62$).
Student achievement was further evaluated by Measured Academic Progress (MAPs) science assessment which assesses student’s ability to understand and use scientific concepts and processes as well as general science knowledge. In the fall prior to treatment, students scored an average Rasch unit (RIT) score of 214 in General Science concepts and a 213 in Concepts & Processes. The post-treatment MAPs scores showed a 2 point increase from 214 to 216 and a 3 point increase in Concepts & Processes from 213 to 216. MAPs estimated RIT score increase from fall to spring is 2 points for both General Science and Concepts & Processes. Of further note, students’ average spring RIT was 216 for both General Science and Concepts & Processes. MAPs estimated achievement for seventh grade students at the end of the year are 210 and 209 respectively. Not only did the students meet the estimated growth, their average scores were 6 RIT scores and 7 RIT scores higher (Figure 4).
The relative change in student attitudes towards science was measured pre- and post-treatment using the Test of Science Related Attitudes (TOSRA). The pre-treatment average student response for all categories was 3.2 while the post-treatment was 3.1. Six of the seven categories showed an average decrease of 0.21. The *Normality of Scientist* category was the one category in which students indicated a positive change in attitude. However, this increase was only 0.1 (Figure 5).
Figure 5. Test of Science Related Attitudes, \((N=68)\).

Prior to treatment, 65% of the students who completed the pre-treatment Learning Preference Questionnaire responded that they preferred working in a group to solve problems through inquiry \((N=65)\), (Appendix B & Figure 6). One student said, “I like working with groups because it gives me a chance to look at things from a different perspective that I may not have thought of on my own,” to explain why comparing answers and sharing ideas helped them learn. Another student responded that, “I like to brainstorm with a partner so we can experiment with our individual ideas and then compare them.” Following the treatment 79% \((N=58)\) of the students who completed the questions pertaining to learning preference on the post-treatment Inquiry Based Instruction Questionnaire indicated that they preferred to problem solve in a group (Appendix C, Figure 6 & Figure 7). To explain how they felt about the process, one
student commented, “I got to learn more and work with my companions.” Another student said, “It was fun to work with my partner and put our heads together made it doubly great.”

Figure 6. Pre-treatment Learning Preference Questionnaire. Mean percent of student responses, (N=65).

Figure 7. Post-treatment Inquiry Based Instruction Questionnaire: Questions pertaining to learning preference. Mean percent of student responses, (N=58).

INTERPRETATION AND CONCLUSION

The effectiveness of the constructivist approach to instruction on achievement via the BSCS 5E Instructional Model in the science classroom was not conclusively supported by data from this project. While the summative unit assessment indicated higher achievement for the students who received treatment than those who did not, the variance was not large enough to categorically say the higher test scores were the result of the treatment. The higher test scores could well be the result of the treatment students having overall higher achievement in science throughout their school career. The
beginning fall MAPs scores for the treatment group were only 1 RIT score below the non-treatment group’s ending spring MAPs scores from the previous year. This indicates the treatment students started at a general higher level of achievement.

Henze (2008) and Hoover (1996) both stressed the importance of students having the opportunity to process new information through interactions with their peers. The treatment components such as Dig In! and the Biome Project, provided ample opportunities for students to compare their interpretations with their peers. However, as Hoover (1996) and Hyslop-Margison and Strobel (2011) maintained, the one factor that impacts student’s ability to integrate new knowledge is time. I do not believe the treatment period was long enough to allow complete integration of the new knowledge, especially since the students had limited prior experiences with the constructivist inquiry process. One student, speaking for their group said, “Why don’t you just give us the answers?” Another important consideration for any lesson is that the students must trust that the integration of new knowledge is worth their time. This is not always an easy task with middle school students.

Students should have been provided with more experiences in the process of the constructivist inquiry process prior to the implementation of the treatment. The unfamiliarity of the process itself negatively impacted students’ comfort level and ultimately affected achievement as well as attitude. Although 74% of the students indicated the inquiry process was a positive experience, the mechanics of cooperative problem solving created unanticipated stumbling blocks for the students and myself. I believe my students were well aware of my anxiety in creating an environment suitable for the inquiry process. Because the process differed from my traditional approach to
teaching, I exhibited a greater degree of stress with the unfamiliar process. I believe my students were also frustrated with the change in the learning atmosphere, and this may be reflected in their final attitude results.

The slight decrease in the students’ science-related attitude may have been influenced by the timing the TOSRA. During the week the post-treatment TOSRA was administered, the students had already experienced two days of science MAPs testing, the post-treatment summative assessment, and MAPs testing in several other subjects. I believe so many assessments certainly affected students’ attitudes. I also must consider the impact of a healthy dose of spring fever that plagues middle school students during warm May days. The combination of so many factors certainly impacts the verity of my results. Although I must consider factors which negatively impacted my results, I also find this information useful for future use of the inquiry process. My awareness of factors which influence my results offers an opportunity to address these issues to ensure a successful inquiry process for future lessons.

VALUE

I found that “accidental” inquiry had the greatest impact on students and on me. These were instances that had not been over planned, but were the natural progression of simple investigations, such as finding the mass of a container full of salt whose total mass was greater than what could be measured at one time by a balance scale. These were the moments in which I observed true constructivism, where students “put their heads together” to solve a problem and their joy in finding a solution was truly a miracle to behold. Although the results of my treatment were inconclusive, one student said it best
when reflecting upon the experience: “It is getting to be rare when an assignment is fun. This project was [fun] and we learned lots!”

Changes within the educational setting rarely come easily or quickly. The process of creating inquiry-based lessons proved to be a far more challenging process than I had originally anticipated for my classroom. While I struggled to incorporate inquiry into every lesson, I noted the lessons which did effectively incorporate inquiry and which guided students to a new level of learning. I also reminded myself that the first step toward change is the desire for change. I reaffirmed my belief that I solidly support constructivist ideas and want constructivist instruction to be the guiding force in my classroom. Douglas Llewellyn (2007), a leading expert in constructivist inquiry scientific education, reminds educators that becoming an inquiry teacher takes time: “You need a Crock-Pot to cook inquiry, not a microwave!” (p. 3). He cautions that a teacher’s first attempts at inquiry may not be successful. Although data did not show a significant change in achievement, I do believe the students’ final projects were superior to previous years’ and that they demonstrated a greater depth of understanding of the workings of biomes (Figures 8 & 9). The growth in student knowledge is evident when the final projects are compared to the initial drawings from the Draw A Biome completed at the onset of the treatment (Figure 10).
Figure 8. Final Project, Student Sample A.

Figure 9. Final Project, Student Sample B.
Through continued reflection and revision, I will move up Llewellyn’s inquiry ladder from rung two, “Consciously incompetent,” to the top rung of “Unconscious competency,” if for no other reason than this student’s comment: “The project was tough, but when we got it done, we felt so educated and proud of ourselves.” This student’s comment alone has motivated me to create a constructivist classroom in which students create their own knowledge and have pride in their accomplishments. One of the greatest values of education is knowing that I am able to teach my students how to take the knowledge in the science classroom to help them open their minds to new opportunities for discovering the science world.
REFERENCES CITED


Connecticut State Department of Education. (2011). *Dig In!*


APPENDIX A

5E LEARNING MODEL TREATMENT ACTIVITIES
<table>
<thead>
<tr>
<th>Phase</th>
<th>Goal</th>
<th>Instruction</th>
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| Engagement | • Stimulate student curiosity  
• Connect to prior experiences  
• Access prior knowledge  
• Expose prior thinking | Activity: Draw a Biome  
Students’ prior knowledge was assessed/activated by drawing a simple model of a biome showing the interactions and relationships between the biotic and abiotic factors. These drawings were collected and saved for student comparison to their final Biome Model at the end of the unit (Appendix D).  
Activity: What Biome Is This?  
Students analyzed precipitation and temperature data to hypothesis the identity of three biomes (Oemig and Archer, n.d.). |
| Exploration | • Provide common experiences for students  
• Facilitate conceptual change | Investigation: Dig In!  
Students designed tests to determine the water-holding capacity of a variety of soils. Hypothesizing which soils may be found in specific biomes (Appendix E).  
Biome Research  
Students researched the abiotic and biotic components of a specific biome to create a mural model of the biome which depicted the interactions between the abiotic and biotic components (Appendix F).  
Biome Mural Model  
Based upon research, students created a mural model of a biome which depicted the interactions between the abiotic and biotic components (Appendix F). |
| Explanation | • Focus students’ attention on concept  
• Provide opportunities for demonstration of knowledge, processes and/or behaviors.  
• Provide conceptual information  
• Develop deeper comprehension | Biome Presentation  
Students made a presentation about the biotic and abiotic interactions based upon their biome research to their classmates. During presentations, students took notes about each biome.  
Activity: Draw a Biome II  
Students revisited their initial biome drawings created during the engagement phase to identify and explain the change in their thinking regarding the biotic and abiotic interactions in their biome. |
| Elaboration | • Challenge students’ understanding of concepts  
• Extend students’ understanding and skills  
• Provide practice for students to apply conceptual understanding | Activity: New Planet  
Students designed a biome based upon provided parameters of temperature and precipitation patterns, as well as other abiotic components, for an unknown location (Appendix G). |
| Evaluation | • Assess understanding and student progress | Summative Assessment  
Students demonstrated knowledge of abiotic and biotic components and interactions found in the major biomes of the world (Appendix H). |
APPENDIX B

LEARNING PREFERENCE QUESTIONNAIRE
Learning Preference Questionnaire

Participation in this research is voluntary and participation or non-participation will not affect your grades or class standing in any way. The purpose of this questionnaire is to best see how you learn. Please answer each question honestly. Your answers will be anonymous.

1. Do you prefer learning on your own, listening to class lectures and discussion, or working with a group?

   Please explain your preference.

2. When solving a problem, do you prefer to be given the steps to find the solution, develop your own way to solve the problem, or work with a partner to brainstorm ideas to solve the problem?

   Please explain your preference.

3. What educational value do you see in group work, if any?

4. Is there anything else you'd like me to know?
APPENDIX C

INQUIRY BASED INSTRUCTION QUESTIONNAIRE
Inquiry Based Instruction Questionnaire

Participation in this research is voluntary and participation or non-participation will not affect your grades or class standing in any way. The purpose of this questionnaire is to provide you with the opportunity to share your opinion on inquiry based instruction on. Check *Agree* or *Disagree* for each statement, then provide further explanation for your selection in the *Comments* column. Please answer each question honestly. Your answers will be anonymous.

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Disagree</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I was motivated to do the project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Project made me want to do my best</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I found the project to be challenging</td>
<td></td>
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<tr>
<td>4. I found the project to be interesting</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5. I am very satisfied with my contribution to the project</td>
<td></td>
<td></td>
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<tr>
<td>6. I enjoyed working on the project</td>
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<td></td>
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<tr>
<td></td>
<td>Agree</td>
<td>Disagree</td>
<td>Comments</td>
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<tr>
<td>7.</td>
<td>The project made it easy to learn about biomes</td>
<td></td>
<td></td>
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<tr>
<td>8.</td>
<td>The other students’ presentations increased my knowledge about biomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>The project improved my presentation skills</td>
<td></td>
<td></td>
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<tr>
<td>10.</td>
<td>I learned how to take notes from websites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>I enjoyed working with a team</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Each team member in my group was able to contribute their ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>My group was supportive and helped each member to solve problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agree</td>
<td>Disagree</td>
<td>Comments</td>
</tr>
<tr>
<td>---</td>
<td>-------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>14. My group worked well together to complete and present our project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. We were able to complete our tasks on time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. We were organized</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. We worked together as a team</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Is there anything else you would like to tell me?

(Neo and Neo, 2009)
APPENDIX D

DRAW A BIOME
ACTIVITY: DRAW A BIOME

1. Assess/activate student’s prior knowledge by having them draw a simple model of their biome including simple drawings showing the interactions between the biotic and abiotic factors.

2. Students should include descriptions of patterns and relationships between the abiotic and biotic factors, such as how the plant and animal characteristics fit the climate found in the biome. (Allow approximately 20 minutes)

3. These drawings should be collected and saved for student comparison to their final Biome Model at the end of the unit.

4. This is a non-graded activity that’s primary purpose is to document students prior knowledge allowing them to establish a base-line of knowledge
APPENDIX E

DIG IN!
Dig In!
Adapted from: www.sde.ct.gov/sde/lib/sde/pdf/curriculum/.../Gr6_Task_Student.pdf

Imagine that your class will be planting a vegetable garden as part of a study about ecosystems. You need to choose the best location for the garden, and one of the important factors is the type of soil.

In this activity, you will observe and compare different types of soil. Then you will investigate factors that may affect how much water the soils can hold and how quickly water can pass through them. Finally, you will apply the results of your investigations to make decisions about the location of a new garden.

1. **Observe** the different soil samples with and without the hand lens. Notice different properties such as color, grain size, lumpiness, etc. Do you notice anything that is alive or was once alive?

2. **Record** your observations in your science notebook. Make an organized list of things you notice and things you wonder.

<table>
<thead>
<tr>
<th>SOIL</th>
<th>NOTICE</th>
<th>WONDER</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. What factors do you think affect how much water a soil can hold? Review the observations you collected and brainstorm ideas with your partners. Factors that might affect water absorption might include:

4. Choose one factor from your list to investigate and write a scientific question.
Experiment #1 – Relationship Between Soil Properties and Water Absorption

To conduct your experiment, you can make a soil testing device like the one in the diagram:

a. Cut the plastic bottle across the middle. Remove the labels and the caps. The bottle top will hold the soil, and the beaker (or the bottle bottom) will catch the water.

b. Position the mesh near the bottle neck so it will keep the soil in the bottle top.

c. Rest the bottle top, neck down, on the bottle bottom so that water poured through the soil in the bottle top will flow into the bottle bottom.

1. In this experiment, the dependent variable is the soil absorbency. Describe how you will change the independent variable, measure the dependent variable, and keep the other factors constant in your experiment. In your science notebook, record the independent variable you will investigate and the variables that must be kept constant in your experiment.

   DEPENDENT VARIABLE:

   ____________________________________________________________

   INDEPENDENT VARIABLE:

   ____________________________________________________________

   CONSTANTS:

   ____________________________________________________________
PREDICTION:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

2. **Design** a procedure that will help you answer your research question. List the steps you will follow in your science notebook. Include enough detail so that anyone could repeat your experiment.

3. Design a **data table** to record your findings in your science notebook.

4. **Get** your teacher’s approval before you begin your experiment.

5. Do your **experiment** and record your findings. Do the data seem reasonable? If not, do you need to repeat any trials to correct errors?

6. **Calculate** the amount of water remaining in each soil.

7. **Interpret** the data. Use your calculations to help you reach a conclusion about what properties affect soil absorbency (how much water the soil holds). Based upon the soil absorbency, determine the biome in which each soil may be found. Be sure to support your conclusions with data.

8. **Share** your procedures and conclusions with others in your class. How are they alike? How are they different? What changes could be made to the procedures to make the results more similar?
APPENDIX F

BIOME MODEL
Your team will become experts on a specific climate and corresponding biome. You will research a climate and biome, create a model poster depicting the climate and biome, and give a three to four minute presentation on the biome model to your classmates.

Schedule:
- Day 4 - 5: Computer lab research
- Day 6 - 7: Library research
- Day 8: Computer lab research
- Day 9: Library research
- Day 10 - 14: Classroom work
- Day 15: Organize Biome Model Presentation
- Day 16 – 18: Biome Model Presentations

PART 1: RESEARCH

Record reference source and information on individual research cards.

**Biotic:**
Research each organism’s behavior, appearance, adaptations, foods, relationships, etc.

**You must have (at least):**

a. **The Most Common** or Abundant **Plant** found in your biome
   --The ‘poster’ plant
   --Describe *characteristics* and *behaviors*
   --Describe or diagram *life cycle*  
   (your text has examples of how to diagram or describe cycle)
   --Describe special *adaptations* (physical or behavioral) that  
   allows the plant to be successful in your biome

b. **The Most Common** or Abundant **Animal** found in your biome
   --The ‘poster’ animal
   --Describe *characteristics*, *behaviors*, and *foods*
   --Describe or diagram *life cycle*  
   (your text has examples of how to diagram or describe cycle)
   --Describe special *adaptations* (physical or behavioral) that  
   allows the animal to be successful in your biome
c. **5 different Producers**—select organisms that are SPECIFIC & COMMON to your biome.

d. **5 different Consumers**—select organisms that are SPECIFIC & COMMON to your biome.

Represent all niche’s in the community:

--Herbivores & their **foods**
--Omnivores & their **foods**
--Carnivores & their **foods**

e. **2 Scavengers**—select organisms that are SPECIFIC & COMMON to your biome

f. **1 Decomposer**—select an organism that is SPECIFIC to your biome (be careful)

g. **Endangered Species** (plant or animal) found in your biome

Put on Poster Back

**Climate & other Abiotic:**

h. **5 Abiotic factors** (climate and others)—that are SPECIFIC to your biome

--Identify the following:

1. Average annual precipitation (dependent on biome)
2. Average winter temperature (dependent on biome)
3. Average summer temperature (dependent on biome)
4. Soil characteristics
5. Average hours of daylight (summer & winter)
6. Wind speed or season most likely to occur

--Use actual measurements and characteristics. Don’t just say ‘rain’, or ‘snow’ instead identify the average precipitation AND what season (time of year) the precipitation is most likely to occur.

As you conduct your research record the **INFORMATION AND ALL SOURCES** on each provided research card. These cards are to be turned in at your presentation.
PART 2: MODEL POSTER
(Poster front)
Create an attractive, interactive, and interesting ‘picture’ of the biome including the biotic and climate/abiotic factors researched. Poster will be used in biome presentation.

Model must include the:
- most common plant
- most common animal
- 5 different producers
- 5 different consumers (herbivores, carnivores, omnivores)
- all consumers’ food sources
- 2 different scavengers
- 1 decomposer
- 1 endangered species
- Climate/abiotic factors

PART 3: ½ Page Discussion
(Poster back)
Research and describe ONE of the following for the biome:

a. How human activities have affected your biome (good & bad).
b. A Native Tribe or Group that makes your biome their home.
c. Summarize a recent news article about your biome. (include a copy)

PART 4: Quiz Cards

Write 20 quiz cards that review the important components (biotic & climate/abiotic) of the biome.

These cards are to be turned in at your presentation.
PART 5: Biome Map  
(Poster back)

Identify the locations of the biome on a world map.

a. Neatly label the continents on your map.
b. Identify where you live (Florence, MT) and mark the spot with a ‘☆’
c. Color the areas of the map in which your biome is found.
d. Include a title and a key for your map.

PART 6: Food Web  
(Poster back)

Diagram the energy transfers for the organisms and food included on the Mural. Be sure to draw arrows from the food to the consumer.

Web must include all of the:
- most common plant
- most common animal
- 5 different producers
- 5 different consumers (herbivores, carnivores, omnivores)
- all consumers’ food sources
- 2 different scavengers
- 1 decomposer
- 1 endangered species

PART 7: Daily Log  
(Attached)

Each student is responsible for keeping a daily log recording the tasks and time spent on each task for themselves and their partner. If work is completed at home, a parent needs to sign the log to verify the time. Logs will be periodically checked and graded.

PART 8: Bibliography  
(Poster back)

Site (list) references/sources from note cards. Include web sites, books, magazines, movies, etc.
PART 9: Class Presentations

Each group will give a three to four minute presentation on their biome to the class. The presentation will provide information essential to understanding the biome.

Include information on:

- most common plant
- most common animal
- 5 different producers
- 5 different consumers (herbivores, carnivores, omnivores)
- all consumers’ food sources
- 2 different scavengers
- 1 decomposer
- 1 endangered species
- climate/abiotic factors
- interesting facts, etc.

Presentation grade is dependent on the group giving an interesting, organized presentation that provides all essential biome components (facts).

PART 10: During Class Presentations

Listen closely while your classmates present their biome. During each presentation, record at least 3 examples of each of the biome’s four components (climate/abiotic, biotic, relationships, interesting facts) on your note charts.
BIOME WEB SITES

These web sites are just a FEW which exist on the internet. Do not limit your search to this list. Use your favorite search engine, Google is a good place to start. Remember your biome may have several names. Also, once you get the name of an organism, do a specific search on the organism.

1. **http://www.radford.edu/~swoodwar/CLASSES/GEOG235/biomes/main.html**
   - high school information, few images

2. **http://mbgnet.mobot.org/**
   - simple information, lots of images, upper elem school

3. **http://www.ucmp.berkeley.edu/glossary/gloss5/biome/**
   - good info, few images, not all biomes

4. **http://ellensplace.net/tundra.html**
   - good line drawings of tundra plants

5. **http://www.enchantedlearning.com/biomes/**
   - student’s favorite, easy to read, lots of info & images

6. **http://www.blueplanetbiomes.org/world_biomes.htm**

7. **http://www.thewildclassroom.com/biomes**

8. **http://www.lsb.syr.edu/projects/cyberzoo/biome.html**


10. **http://ths.sps.lane.edu/biomes/index1.html**

11. **http://www.runet.edu/~swoodwar/CLASSES/GEOG235/biomes/intro.html**

12. **http://www.enature.com/home/**

   - Excellent information for SPECIFIC plants and animals, go here once you have a name
Biome Model Contract

I, _________________________ agree to work with ______________________ (name) {and ______________________ (name)} in a team project to become experts on the _______________________ Biome. I realize that we are working together for a specific purpose and that following basic Group Rules will allow everyone to be successful.

THREE BASIC GROUP RULES:
1. Stay with your group.
2. Ask a question of your group first, before you ask your teacher.
3. Offer feedback on ideas; avoid criticizing people.

EVALUATION:
Each individual will be periodically evaluated during the project by the teacher, the team, and through self-evaluation on the following criteria:

- Being well prepared with supplies, notes, etc.
- Completing all individual tasks on time and with quality.
- Contributing during team discussions.
- Encouraging others to contribute during discussions.
- Actively listening to others.
- Tolerant of different viewpoints.
- Working with the team to accomplish the team’s goal on time and with quality.

The project ‘grade’ will be a separate evaluation based on the Scoring Rubric in your Biome Packet. Each individual on the team will earn the portion of the project grade that is indicated by the individual’s participation.

ABSENCES:
The team will suggest appropriate make-up work for any member who has been absent. Once approved by the teacher, the student must complete the make-up work before the next class period.

I, ____________________________ commit to a timely and quality completion of the following tasks:

<table>
<thead>
<tr>
<th>BIOME TASKS (be specific, ex: research 3 producers)</th>
<th>Due Date</th>
<th>Date Completed</th>
<th>Quality: +, ok, -- (team evaluated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
BIOME NOTE CARDS

BIOME: _________________________________

CONSUMERS (note: make 6 copies per team)

Name: _________________________________________________________

Description (Physical & Behavioral):

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

Herbivore / Carnivore / Omnivore

Foods:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

SOURCE / REFERENCE

_________________________________________________________________
_________________________________________________________________
BIOME: ________________________________

PRODUCERS (note: make 6 copies per team)

Name: __________________________________________________________

Description (Physical):

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

GROWING CONDITIONS:

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

SOURCE / REFERENCE

_________________________________________________________________

_________________________________________________________________
BIOME: _________________________________

SCAVENGERS (note: make 2 copies per team)

Name: _________________________________________________________

Description (Physical & Behavioral):

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

Foods:

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

SOURCE / REFERENCE

_________________________________________________________________

_________________________________________________________________
BIOME: _________________________________

COMMON ANIMAL

Name: _________________________________________________________

Description (Physical, Behavioral, Adaptations):

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

Foods:

_________________________________________________________________

LIFE CYCLE:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

SOURCE / REFERENCE

_________________________________________________________________
_________________________________________________________________
BIOME: _________________________________

DECOMPOSER

Name: _________________________________

Description (Physical & Behavioral):

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

Foods:

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

SOURCE / REFERENCE

__________________________________________________________________________

__________________________________________________________________________
BIOME: _________________________________

ENDANGERED SPECIES

Name: __________________________________________________________

Description (Physical & Behavioral):

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

STATUS: _________________________________________________________

DATE LISTED: ____________________________

POPULATION: ___________________________

HABITAT (PHYSICAL):

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

RANGE (GEOGRAPHIC):

____________________________________________________________________

THREATS: _________________________________________________________

____________________________________________________________________

SOURCE / REFERENCE

____________________________________________________________________
BIOME: _________________________________

INTERESTING FACTS/INFORMATION

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

SOURCE / REFERENCE

________________________________________________________________________

________________________________________________________________________
BIOME: _________________________________

CLIMATE & OTHER ABIOTIC FACTORS

Be sure to include specific climatic conditions and abiotic characteristics of your biome.
Ave. Precipitation: _________________________________
Ave. Temperature: _________________________________
(include extremes)

Other Abiotic Factors:
____________________________________
____________________________________
____________________________________
____________________________________
____________________________________
____________________________________

SOURCE / REFERENCE
____________________________________
MARINE/OCEAN SUPPLIMENT

Diagram the ZONES of the ocean on the poster. Describe the abiotic conditions of each Zone. Identify the organisms which live in each Zone.

<table>
<thead>
<tr>
<th>ZONES</th>
<th>Abiotic Conditions</th>
<th>Organisms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light, Oxygen level, Temperature</td>
<td></td>
</tr>
</tbody>
</table>

SOURCE / REFERENCE
FRESHWATER/LAKE SUPPLIMENT

Diagram the ZONES of a lake on the poster.
Describe the abiotic conditions of each Zone.
Identify the organisms which live in each Zone.

<table>
<thead>
<tr>
<th>ZONES</th>
<th>Abiotic Conditions</th>
<th>Organisms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light, Oxygen level, Temperature</td>
<td></td>
</tr>
</tbody>
</table>

SOURCE / REFERENCE
Biome Model Grading Rubric

Biome: _______________________ Cl. Hr.: ______ Students: _______________________

Final Score: _______ (330) Possible

PRESENTATION & MODEL

_____ (20) Producers ____________________________

_____ (8) Scavengers ____________________________

_____ (4) Decomposer ____________________________

_____ (10) Climate/Abiotic

Ave. Temp: S/D_________________ W/N___________

Ave. Precip: ____________________________

_____ (2) Common Plant ____________________________

_____ (2) Common Animal ____________________________

_____ (2) Endangered Species ____________________________

_____ (25) Consumers ____________________________

eats ____________________________

eats ____________________________

eats ____________________________

eats ____________________________

eats ____________________________

H = Herbivore,  C = Carnivore,  O = Omnivore (- 3/missing category)

_____ (80) Total

PRESENTATION

_____ (20) Provided essential information-1/3

_____ (10) Organized

_____ (10) Interesting

_____ (40) Total

MODEL

_____ (20) Interactive, Colorful, Perspective

Comments:
Most Common Plant

_____ (10) Description
_____ (4) Life Cycle
_____ (3) Adaptation
_____ (3) Growing Conditions
_____ (20) Total

Most Common Animal

_____ (10) Description
_____ (4) Life Cycle
_____ (3) Adaptation
_____ (3) Food
_____ (20) Total

Endangered Species

_____ (2) Status: Th or E
_____ (2) Date listed
_____ (2) Population
_____ (2) Habitat
_____ (2) Range
_____ (2) Threats
_____ (12) Total

Map

_____ (5) Continents
_____ (2) Florence
_____ (10) Biome
_____ (2) Title
_____ (11) Key
_____ (30) Total

Discussion

a. Human Activity
b. Native Population
c. News Article

_____ (20) Total

Food Web

_____ (20) Organisms 15-20
_____ (10) Energy Transfer Arrows
_____ (30) Total

Quiz Cards_____ (20) Total

Research Cards_____ (20) Total

Bibliography_____ (18) Total
Each student will keep a daily work log for themselves AND their partner/s. Record the work and the time spent working EACH day.

<table>
<thead>
<tr>
<th>Date</th>
<th>Describe task</th>
<th>Time</th>
<th>Total Time (minutes)</th>
<th>Date</th>
<th>Describe task</th>
<th>Time</th>
<th>Total Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Start</td>
<td>Stop</td>
<td></td>
<td></td>
<td>Start</td>
<td>Stop</td>
</tr>
</tbody>
</table>
APPENDIX G

NEW PLANET

New Planet
A new planet has been discovered that appears to have conditions favorable for life. NASA is planning to send an expedition to the new planet. Unmanned probes have recorded information about precipitation, temperature, and soil conditions. To prepare for the manned expedition, NASA must determine what organisms the explorers may encounter. Your job, as NASA’s Chief Ecologist is to create a ‘picture’ of what the explorers may encounter based upon the abiotic conditions measured by the unmanned probe.

(Teacher note: Students will randomly draw one of the four unknown biomes.)

<table>
<thead>
<tr>
<th>Unknown Biome</th>
<th>Precipitation</th>
<th>Temperature</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abicorn</td>
<td>Almost none</td>
<td>hot or cold</td>
<td>poor</td>
</tr>
<tr>
<td>Befeld</td>
<td>Dry</td>
<td>cold</td>
<td>frozen</td>
</tr>
<tr>
<td>Canterall</td>
<td>Very wet</td>
<td>always warm</td>
<td>poor, thin soil</td>
</tr>
<tr>
<td>Diagon</td>
<td>Wet season, dry season</td>
<td>warm to hot</td>
<td>fertile soil</td>
</tr>
</tbody>
</table>
APPENDIX H

SUMMATIVE ASSESSMENT
TEST: BIOMES

Write the letter of the BEST answer on the line at the left.

_____ 1. The average weather conditions in a specific place, over a long period of time is it’s
   a. habitat.  b. ecosystem.  c. biome.  d. climate.

_____ 2. Most conifer(ous) trees are also known as
   a. palms.  b. cacti.  c. evergreens.  d. algae.

_____ 3. A biome that is very cold and dry is the
   a. coniferous forest.  b. tundra.  c. temperate deciduous forest.  d. grassland.

_____ 4. The biome that is most likely to contain plants with fleshy water-storing stems is the
   a. coniferous forest.  b. tropical rain forest.  c. temperate deciduous forest.  d. desert.

_____ 5. The biome which usually contains orchids, ferns and other plants that live on the branches of trees is the
   a. tundra  b. coniferous forest  c. temperate deciduous forest  d. tropical rain forest

_____ 6. Which of the following is a NOT a form of precipitation?
   a. sleet  b. rain  c. hail  d. permafrost
Write the name of the biome where each of the following organisms would MOST likely be found in large numbers.

<table>
<thead>
<tr>
<th>Savanna Grassland</th>
<th>Tundra Coniferous Forest</th>
<th>Tropical Rain Forest Saltwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. roadrunner: _____________________</td>
<td>12. acacia tree: _____________________</td>
<td></td>
</tr>
<tr>
<td>2. bison: _____________________</td>
<td>13. prairie dog: _____________________</td>
<td></td>
</tr>
<tr>
<td>3. trout: _____________________</td>
<td>14. gray wolf: _____________________</td>
<td></td>
</tr>
<tr>
<td>4. opossum: _____________________</td>
<td>15. fir tree: _____________________</td>
<td></td>
</tr>
<tr>
<td>5. pine trees: _____________________</td>
<td>16. blue whale: _____________________</td>
<td></td>
</tr>
<tr>
<td>6. poison arrow frog: _____________________</td>
<td>17. scorpion: _____________________</td>
<td></td>
</tr>
<tr>
<td>7. caribou: _____________________</td>
<td>18. elephant: _____________________</td>
<td></td>
</tr>
<tr>
<td>8. bromeliad: _____________________</td>
<td>19. maple tree: _____________________</td>
<td></td>
</tr>
<tr>
<td>9. coral: _____________________</td>
<td>20. cattail: _____________________</td>
<td></td>
</tr>
<tr>
<td>10. oak trees: _____________________</td>
<td>21. lemming: _____________________</td>
<td></td>
</tr>
<tr>
<td>11. lichen: _____________________</td>
<td>22. saguaro: _____________________</td>
<td></td>
</tr>
</tbody>
</table>

Identify each of the organisms as living in a saltwater or freshwater biome.

A. ___________________  B. ___________________  C. ___________________

A. Kelp  B. Beaver  C. Starfish

A. Orca  B. Frog  C. Shark
D. ___________________ E. ___________________ F. ___________________

**Answer the Following video questions.**

1. What abiotic factor has the greatest influence in creating North American grasslands.

2. While the tropical rainforest has more biological diversity than any other biome the quality of the soil is very ________________.

3. What biome is called a ‘cold desert’?

4. How wide must a flowing body of water be to be considered a river?

5. What does the word “deciduous” mean?

6. (a-e) Use the following terms to label the layers of the forest: **canopy, emergent, forest floor, herb/under growth, understory /shrub**
For each organism describe an adaptation that helps it to survive in its’ biome.
THEN:
Identify the biome the organism would be found in large numbers.

1a. adaptation: _______________________
1b. biome: __________________________

Cactus

1a. adaptation: ______________________
Blue Crown

3a. adaptation: _______________________

_________________________________

3b. biome: ____________________________

4b. biome: ____________________________

Caterpillar

2a. adaptation: _______________________

____________________________________

2b. biome: ____________________________

Musk Oxen

5a. adaptation: _______________________

____________________________________

5b. biome: ____________________________

Maple Tree

4a. adaptation: _______________________

Pine Tree

7a. adaptation: _______________________

_________________________________
6a. adaptation: ______________________________________

6b. biome: ______________________________________

8a. adaptation: ______________________________________

8b. biome: ______________________________________

Water Lily

Assorted flowers and grasses
Identify each illustration below as one of the following biomes:

<table>
<thead>
<tr>
<th>Freshwater</th>
<th>Coniferous forest</th>
<th>Deciduous forest</th>
<th>Tundra</th>
<th>NA Grassland</th>
<th>Savannah</th>
<th>Saltwater</th>
<th>Tropical Rainforest</th>
<th>NA Desert</th>
<th>African Desert</th>
</tr>
</thead>
</table>

A. ________________________________
B. ________________________________
C. ________________________________
D. ________________________________
E. ________________________________
F. ________________________________
G. ________________________________
H. ________________________________